Bias and Trend Characteristics of AIRS Cloud-Cleared Radiances

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Overview

- Are the cloud-cleared radiances contributing to the Level 2 trend problem?
- Do the cloud-cleared radiances exhibit any unphysical behaviors?

Approach

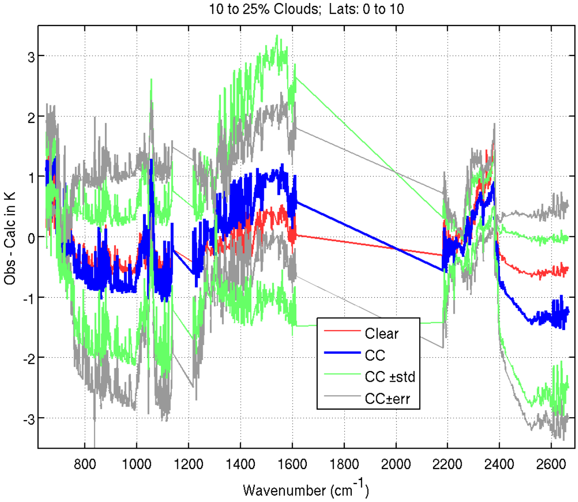
- AIRS L1b clear data set (ACDS) used as basline/standard.
- AIRS L1b Clear - ERA Interim = Clear Bias
- AIRS L2CC - ERA Interium = CC Bias
- Examine Clear Bias - CC Bias
- ERA Interium trends and CO_2 trends largely drop out

AIRS L1b Stability?

- CO_2 rate extremely well measured at Mauna Loa, HA
- Obs = dB(T)/dt of L1b 791.7 cm^{-1} channel, $\pm$10 deg. latitude of MLO
- Calc = ERA Interim + MLO CO_2 rate
- Obs - Calc Rate = 1.9 $\pm$ 3.8 mK/year (2σ)
- Basically says ERA Interim and AIRS trends agree. ERA biases set by world-wide radiosonde network.

Example: 10-25% Cloud in FOR, 0°to +10°Lat.

Clear = L1b ACDS, CC = Cloud-cleared, std = Bias Std, err = CC error in L2



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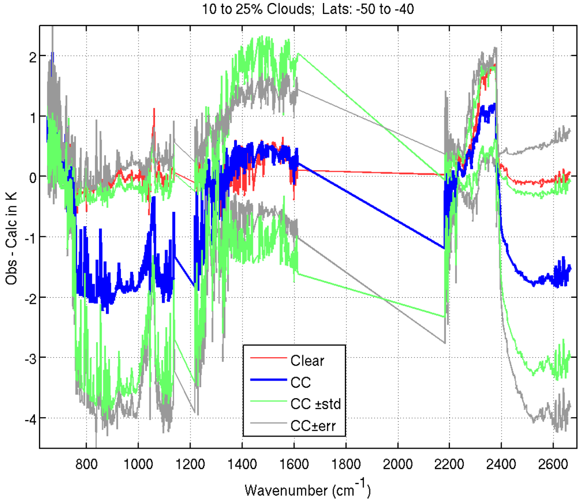
Example: 10-25% Cloud in FOR, -40°to -50°Lat.

Note large cold bias for CC in windows



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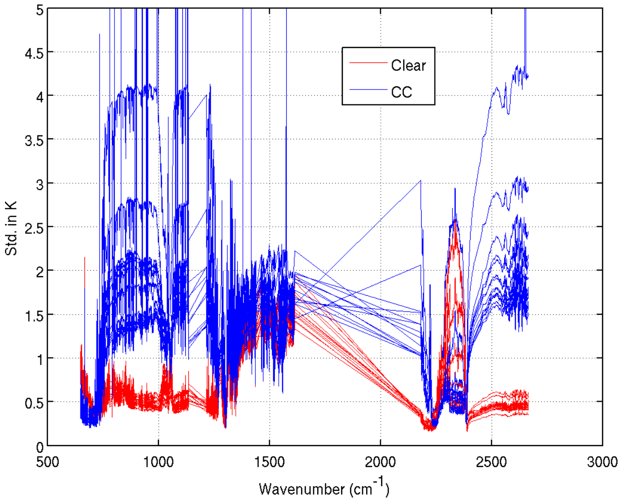
Std. Dev. of L1b vs L2 CC (all lats)

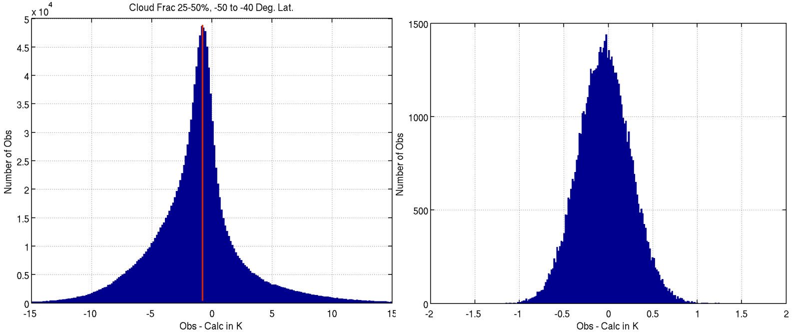
Note CC std better in longwave as expected



Histograms of -50°to -40°Biases (961 cm^{-1})

Shows cloud leakage

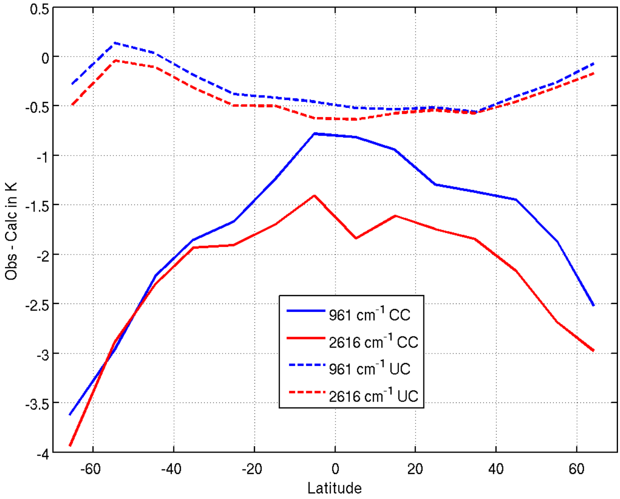
L2 CC Bias L1b Clear



Note different scales for Obs-Calc.

Window Channel Bias vs Latitude (25-50% Clouds)

CC = L2 CC BT Bias, UC = L1b Clear BT Bias



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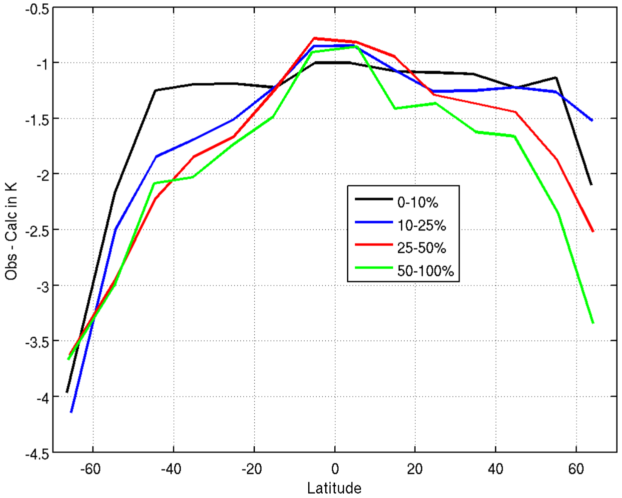
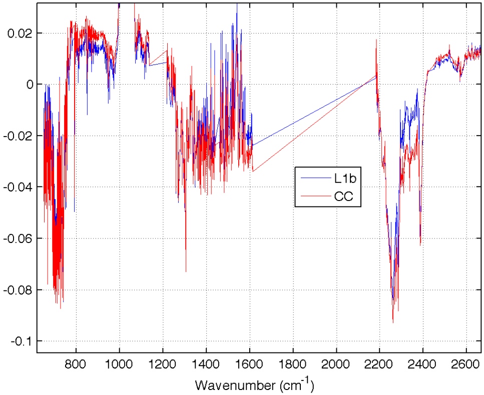
Window Channel Bias vs Latitude vs Cloud Amount

961 cm^{-1} Channel

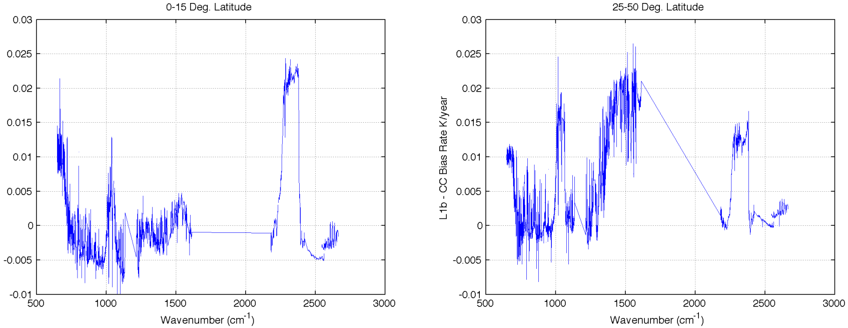


L1b versus L2CC Radiance Rate Trends

Fit $bias_j = a_j + b_j * t + \sum_{i=1}^{4} c_{ij} sin(\omega_i t + \phi_{ij})$
$\omega_1 = 2\pi, \omega_2 = 4\pi, ...$
Radiance bias rate spectrum is then $b_j, j = 1 : 2378$.
(Used 2004-2010, tropics, CC nadir views. Y-axis is K/year)



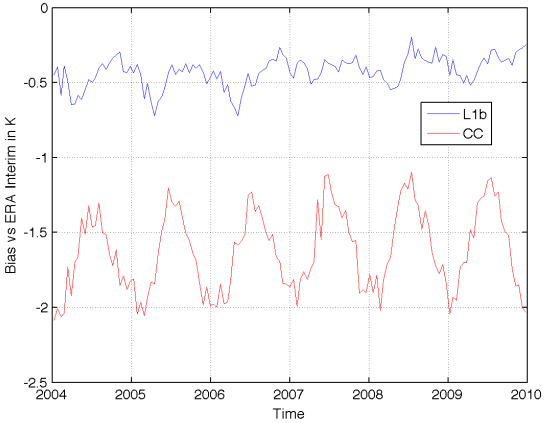
Difference in L1b and L2CC Bias Rates



Difference in water band rate for 25-50 deg. latitude probably due to L1b clear vs cloud-cleared sampling differences at higher latitudes.

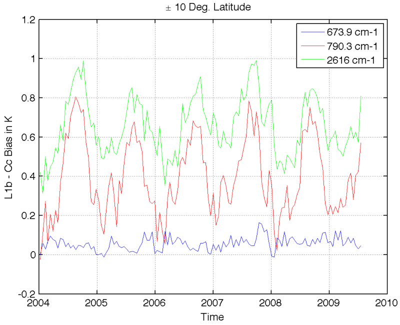
Time Dependence of L1B versus L2CC Biases

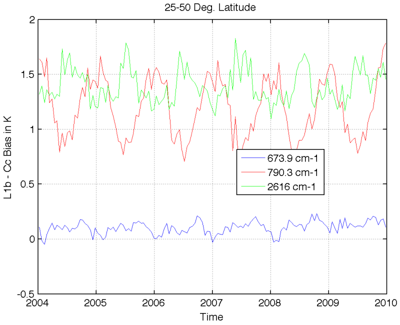
25-50 Deg. Lat



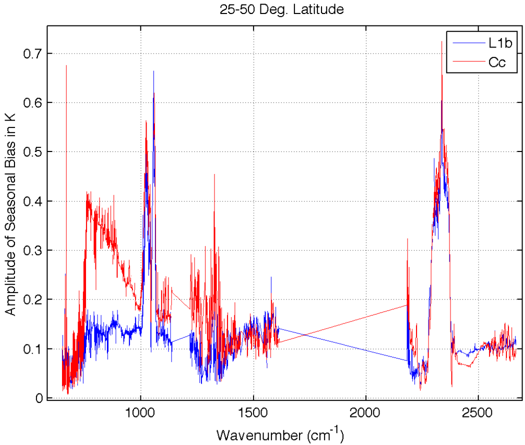
Cloud-clearing biases in window regions are seasonally dependent. Phase shifts by π in Southern Hemisphere

Time Dependence of L1B minus L2CC Biases





Frequency Dependence of Seasonal Bias Variations



These are the c_{1j} terms in the bias rate equation (fundamental amplitude)

Conclusions

- Cloud-cleared radiances have very significant cold biases in channels sensitive to the surface. This includes many sounding channels.
- Probability distribution functions of cloud-cleared biases exhibit non-Gaussian wings that are as large as 10K or more in the high latitudes.
- The biases vary with season and latitude and are as high as 6K at -60 deg. latitude
- Trends in window region cloud-cleared radiances are identical to clear L1b trends.
- Some differences in L1b and CC radiance bias trends in cold channels seen at the 0.01K/year level. Accuracy of this differential trend difficult to estimate.
- Large cloud-cleared radiance biases, with large tails in their population distribution, makes one question their suitablility for climate trending.
- Seasonal variations in cloud-cleared radiance are also a concern.